SCREENING SITE INSPECTION REPORT
FOR
PIG'S EYE LANDFILL

ST. PAUL, MINNESOTA
U.S. EPA ID#: MND980609085

VOLUME I

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1.0 EXECUTIVE SUMMARY

Minnesota Pollution Control Agency (MPCA) staff has conducted a Screening Site Inspection (SSI) at Pig's Eye Landfill in St. Paul, Minnesota. The purpose of the SSI was to determine if the landfill has contaminated surrounding ground water and surface water.

A total of 6 soil samples, 6 ground water samples, 2 surface water samples and one residential well sample were obtained during the SSI. Chemical analysis of the samples revealed contaminants from the following groups: solvents, hydrocarbons, polynuclear aromatic hydrocarbons (PAH) and heavy metals. The presence of these contaminants in the soil and ground water indicates that Pig's Eye Landfill has impacted the environment.

2.0 INTRODUCTION

The MPCA working under Cooperative Agreement No. V005848-01 with the U.S. Environmental Protection Agency (EPA), has conducted a SSI at Pig's Eye Landfill (Site). The Site was first brought to the attention of the EPA on June 1, 1981. On this date, EPA received a "Notification of Hazardous Waste Site" form from Beermann Services of Inver Grove Heights, Minnesota. The form disclosed that Beermann Services hauled barrels of solvents and paint sludges to Pig's Eye Landfill along with mixed municipal waste.

The Site was placed on EPA's Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) inventory and was evaluated in the form of a Preliminary Assessment (PA) dated March 1, 1983. The PA was conducted by Lisa Peserchio of Ecology and Environment, Incorporated. The Site was assigned EPA identification number MND980609085.

The MPCA staff prepared and submitted a SSI Work Plan for EPA, Region 5 staff to review. The SSI Work Plan was approved by the EPA on December 5, 1988. The SSI for Pig's Eye Landfill was conducted from December 11, 1988, to January 12, 1989.

The objectives of an SSI have been stated by EPA in a directive outlining pre-remedial strategies:

The directive states:

> All sites will receive a SSI to: 1) collect additional data beyond the PA to enable a more refined preliminary Hazard Ranking System (HRS) Score, 2) establish priorities among sites most likely to qualify for the National Priorities List (NPL), and 3) identify the most critical data requirements for the listing SI step (U.S. EPA 1988).

3.0 Site Data

3.1 Site Description

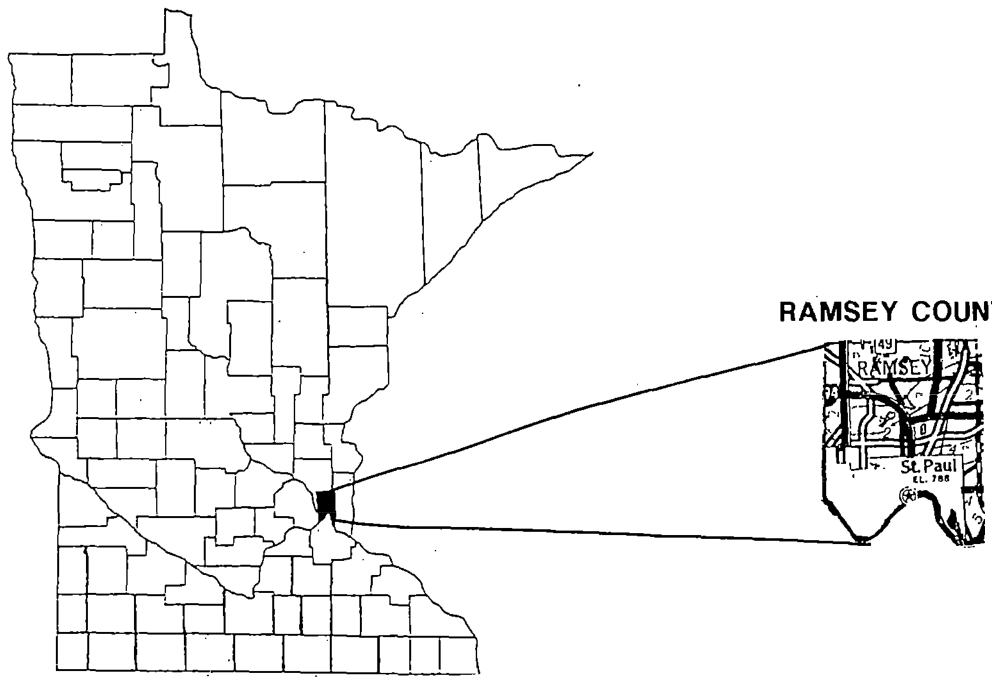
The Site is located ½ mile southeast of the intersection of Warner Road and Childs Road in St. Paul, Ramsey County, Minnesota (Figure 3-1). The Site covers an area of approximately 307 acres. The Site is currently inactive except for a wood chipping facility operated by the city of St. Paul. The Site is bordered by the Soo Line Railyard, Metropolitan Waste Control Commission (MWCC) Sewage Treatment Facility and Pig's Eye Lake. There is a residential area approximately ½ mile east of the Site (Figure 5-2). The city of St. Paul, CME Real Estate Company and MWCC currently own property at the Site.

3.2 Site Background

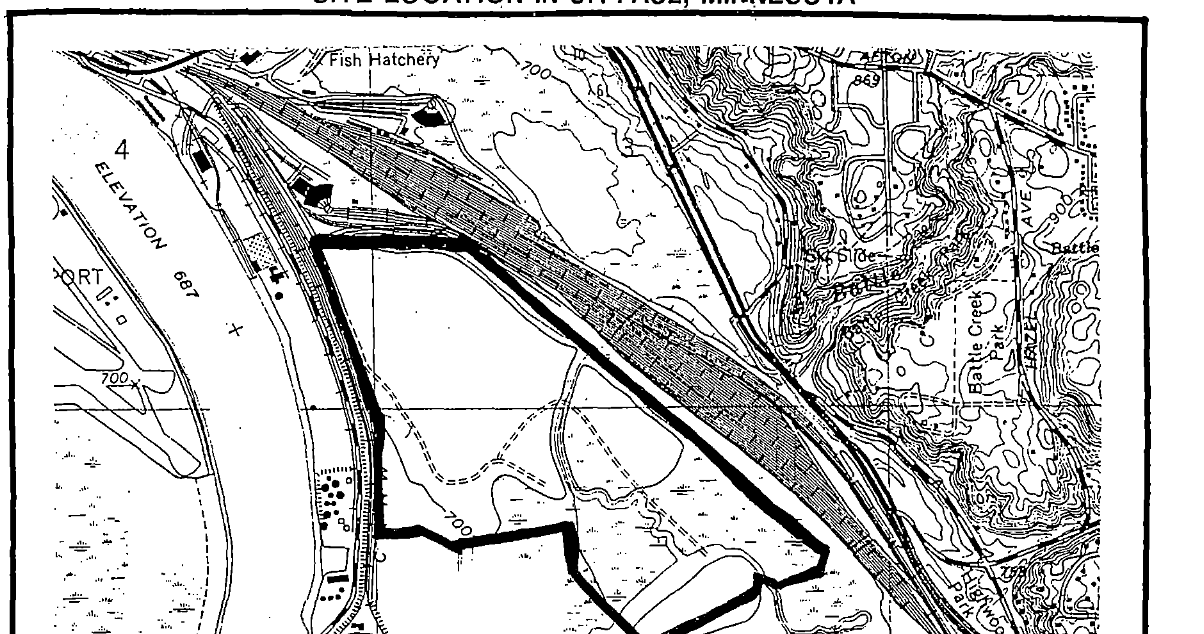
Pig's Eye Landfill began accepting refuse in approximately 1956. The landfill preceded the creation of the MPCA, thus it was not a permitted Site. The landfill served greater than seventy percent of the population of St. Paul and southern suburbs for disposal of residential, commercial and industrial wastes. A yearly volume of 1,725,000 cubic yards of waste was disposed of at the Site (MPCA Files). The Site was closed by the MPCA on July 1, 1972.

MINNESOTA

RAMSEY COUNTY



SITE LOCATION IN ST. PAUL, MINNESOTA



SOURCE: MPCA 1989

FIGURE 3-1: SITE LOCATION

In December 1977, MWCC was permitted to dispose of sewage sludge ash from the MWCC sewage treatment plant on 31 acres of the abandoned landfill. Permit SW-189 was renewed in 1979 and 1985. It is estimated that a total of 435,000 cubic yards of ash were disposed of on site. The ash disposal area has been covered with 6 inches of topsoil and seeded.

In December 1980, a former private waste hauler who had used the dump, registered a complaint with the MPCA concerning 3M Corporation dumping. Complainant #524 stated he witnessed 3M Corporation employees dumping 55-gallon drums at the Site and posting security guards around the perimeter of the dumping area. The complainant was unable to indicate an exact date, but stated it was in 1970 or 1971 (MPCA Files).

The MPCA conducted an on-site inspection of the closed dump in October 1980. The MPCA staff person observed leachate generation along the southern margin of the Site adjacent to Pig's Eye Lake and along Battle Creek, which flows through the Site (Figure 5-2). Photographs of the inspection are available in MPCA files.

During the summer of 1988, the Site caught fire and burned intermittently for over two months. Drages tube testing performed during the fire detected hydrogen cyanide in the smoke. The source of the fire is thought to be from either a lightening strike, a spark from a maintenance truck or vagrant activity. The media coverage of the fire brought the Site to the attention of the public once again. Since the fire, many citizen complaints have been registered with the MPCA regarding the Site.

Based upon the past history of Pig's Eye Landfill, MPCA staff initiated a SSI at the Site. A formal access agreement was sent to CMC Real Estate Corporation, the city of St. Paul and MWCC on November 29, 1988. Signed access agreements were returned to the MPCA within three weeks by MWCC and the city of St. Paul. CMC Real Estate Corporation denied the MPCA access to its property. The SSI was conducted on MWCC and city of St. Paul property in December 1988.

4.0 OBJECTIVES

The principle objective of the Pig's Eye Landfill SSI was to determine if the ground water and surface water in the area has been impacted by the Site. MPCA staff feels the objectives of this SSI have been met.

5.0 GEOLOGY

5.1 Site Topography

The Site is located in a large flood plain on the eastern bank of the Mississippi River. The Site is relatively flat, but has not been fully graded to reduce low areas which tend to collect standing water during periods of heavy precipitation. The overall trend of the slope is to the southwest, toward Pig's Eye Lake and the Mississippi River. Due to the Site's location, it is extremely susceptible to flooding by the Mississippi River. In November 1965, the Site and surrounding low-lying area was completely inundated by water from the Mississippi River. Upstream dam control developed over the last two decades has reduced the potential for future flooding (Figure 5-2).

5.2 Site Geology

Prior to being utilized as a dump, the Site was a low lying area containing two (2) lakes with surrounding marsh areas (St. Paul Solid Waste Files). The original Site area was typical of a lower river terrace area and/or flood plain that are characterized by swampy peat deposits or clay, sand, and gravel alluvium. These environments are reflected in and around Pig's Eye Lake in areas where dumping or filling has not occurred (MPCA Files).

Previous hydrogeologic investigations indicate the flood plain underlying the Site has alternated between a swamp area to an alluvial point bar at least four times since the last bedrock erosional event. The alluvial sequences are characterized by sand to silty clay lenses and layers, while the swampy areas are distinguished by peat and other organic deposits. Peat is concentrated in the upper layers of the natural soils but is more dispersed in lower alluvium sequences. The result of the intermingling of depositional sequences is an extremely heterogeneous unconsolidated matrix (Soil Exploration Company, 1974 and Consulting Engineers Diversified, Incorporated/CH2M Hill, Incorporated, 1979).

Depth to bedrock varies east to west across the Site from 20 to 100 feet. This is due to steep walled buried bedrock river channels trending north to south beneath the unconsolidated deposits and fill at the Site (Figure 5-3) (Soil Exploration Company, 1974, and Consulting Engineers Diversified, Incorporated/CH2M Hill, Incorporated, 1979). Fill thickness varies from 10 to 24 feet in the area the SSI was conducted (Appendix E). The exact location of the fill/soil interface is difficult to discern due to the reworking of waste material in the soft peat deposits. Fill included household waste, various industrial demolition waste, cellophane, and paper products. Very little decomposition of the waste has occurred.

The eroded bedrock unit beneath the alluvium, peat and fill is the Prairie du Chien Group and is comprised of the Shakopee and Oneata formations. A typical bedrock sequence of the area is shown in Figure 5-1. The Prairie du Chien Group is comprised of two carbonate formations. The uppermost unit is the Shakopee Formation and is characterized by fine to medium grained sandstone and quartzitic dolomite layers "with minor amounts of shale and pure dolomite" (Sims and Morey, 1982). The lower Oneata Formation is more dolomitic than the above lying Shakopee and is distinguished by the presence of stomatolite beds and chert in certain areas (Delin and Woodward, 1979).

The Jordan Formation underlies the Prairie du Chien Group. The Jordan is easily identifiable in comparison with the Oneata Formation, as it is a medium to fine grained quartzose sandstone. Formations underlying the Jordan are described briefly in Figure 5-1.

5.3 Regional Hydrology

The primary bedrock aquifer in the Site area is the Prairie du Chien - Jordan. The Prairie du Chien - Jordan aquifer is one of the major ground water resources in the Twin Cities. The Prairie du Chien - Jordan aquifer covers approximately 10,500 square miles in southeastern Minnesota and averages 345 feet in thickness. Hydraulic conductivities range from 1.4×10^{4} to 1.8×10^{5} cm/sec

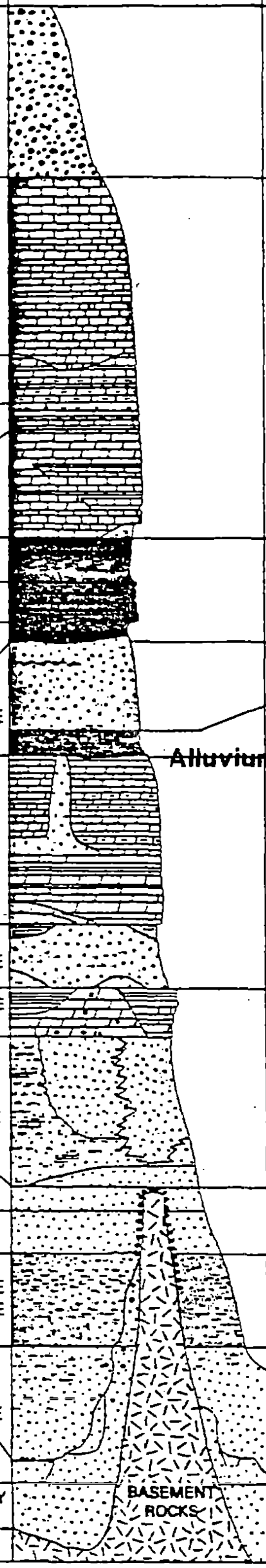
(Kanivetsky and Walton, 1979). Although the Prairie du Chien Group and the Jordan Formation are distinct geological units, they are considered as one hydrological unit due to the lack of a confining layer between the two formations (Delin and Woodward, 1982).

The regional ground water flow direction is strongly influenced by the Mississippi River, as well as the westward regional slope of the bedrock. Generally, the regional ground water flow direction is to the west to southwest, as the Mississippi River serves as a ground water discharge point (Figure 5-3 and 5-4). Localized features such as buried stream valleys, discontinuous clay or peat layers, and man-made features may also influence ground water flow direction in the unconsolidated alluvium associated with the Mississippi River Valley (Delin and Woodward, 1982). The underlying St. Lawrence Formation impedes vertical migration of ground water due to shale and silt areas.

5.4 Site Hydrology

Ground water flow in the bedrock aquifer could not be verified due to lack of monitoring wells necessary to establish head levels. However, previous studies have shown the Mississippi River has a strong influence on ground water flow direction in both the bedrock and surficial aquifers (Norvitch and Walton, 1979). For purposes of this SSI, the ground water flow direction in the bedrock is assumed to be from east to west, toward the Mississippi River (Figure 5-3).

Figure 5-5 shows the direction of ground water flow in the surficial aquifer at the Site is in a southern to southwestern direction discharging to the Mississippi River and Pig's Eye Lake. Ground water elevations are based on



EON AND ERA	PERIOD	GEOLOGIC UNIT	WATER-BEARING CHARACTERISTICS
CENOZOIC	QUATERNARY	UNDIFFERENTIATED DRIFT	UNDIFFERENTIATED DRIFT AQUIFER—Used primarily for domestic and farm purposes throughout area and for municipalities along the western boundary. The aquifer consists of till, alluvium, buried and surficial outwash, valley train, lake, and ice-contact deposits. Yields are highly variable but up to 5000 gal/min have been obtained from wells in outwash and alluvial deposits. **Absent**
PALEOZOIC	DEVONIAN	CEDAR VALLEY LIMESTONE	UPPER CARBONATE AQUIFER—Most extensively used aquifer in south-central part of study area. Permeability is attributed to extensive karst development. Well yields range from 200 to 500 gal/min but are highly variable because solution cavities and channels differ in size and distribution.
	ORDOVICIAN	MAQUOKETA SHALE DUBUQUE FORMATION GALENA DOLOMITE	**Absent**
		DECORAH SHALE PLATTEVILLE FORMATION GLENWOOD SHALE	DECORAH-PLATTEVILLE-GLENWOOD CONFINING BED—Small quantities of water from fractures and solution cavities may be obtained locally from the Platteville. **Absent**
		ST. PETER SANDSTONE	ST. PETER AQUIFER—Yields typically range from 100 to 250 gal/min, but yields of 1200 gal/min have been obtained. Sandstone is poorly cemented, and wells tend to fill with sand. BASAL ST. PETER CONFINING BED—Siltstone and shale in basal St. Peter restricts vertical flow. **Alluvium and Swamp Deposits**
		PRAIRIE DU CHIEN GROUP UNDIVIDED	PRAIRIE DU CHIEN-JORDAN AQUIFER—Most extensively used aquifer in the study area. Hydraulic conductivity is due to joints, fractures, and solution cavities in the Prairie du Chien and to coarse-grained sandstone in the Jordan. Yields of wells commonly range from 500 to 1000 gal/min and can exceed 2000 gal/min.
	CAMBRIAN	JORDAN SANDSTONE	
		ST. LAWRENCE FORMATION FRANCONIA FORMATION	ST. LAWRENCE-FRANCONIA CONFINING BED—Vertical hydraulic conductivity is impeded by silty or shaly beds. Small quantities of water may be obtained from the medium- to coarse-grained Mazomanie Member of the Franconia Formation.
		IRONTON SANDSTONE GALESVILLE SANDSTONE	IRONTON-GALESVILLE AQUIFER—Yields range from 100 to 500 gal/min. Wells are commonly completed through the underlying Mount Simon-Hinckley and are reported as Dresbach.
		EAU CLAIRE SANDSTONE	EAU CLAIRE CONFINING BED—Hydraulic conductivity is poorly known. Sandstone beds in extreme southeastern Minnesota may yield small quantities of water.
		MOUNT SIMON SANDSTONE HINCKLEY SANDSTONE	MOUNT SIMON-HINCKLEY AQUIFER—Only bedrock aquifer used in northern part of study area. Well yields generally range from 200 to 700 gal/min. Locally, as much as 2000 gal/min may be obtained.
PROTEROZOIC		SEDIMENTARY ROCKS BASEMENT ROCKS	CONFINING BED—Hydraulic characteristics are poorly known.

EXPLANATION

Till, sand, and gravel — Limestone — Sandstone — Dolomite — Shale

FIGURE 5-1: HYDROGEOLOGIC COLUMN

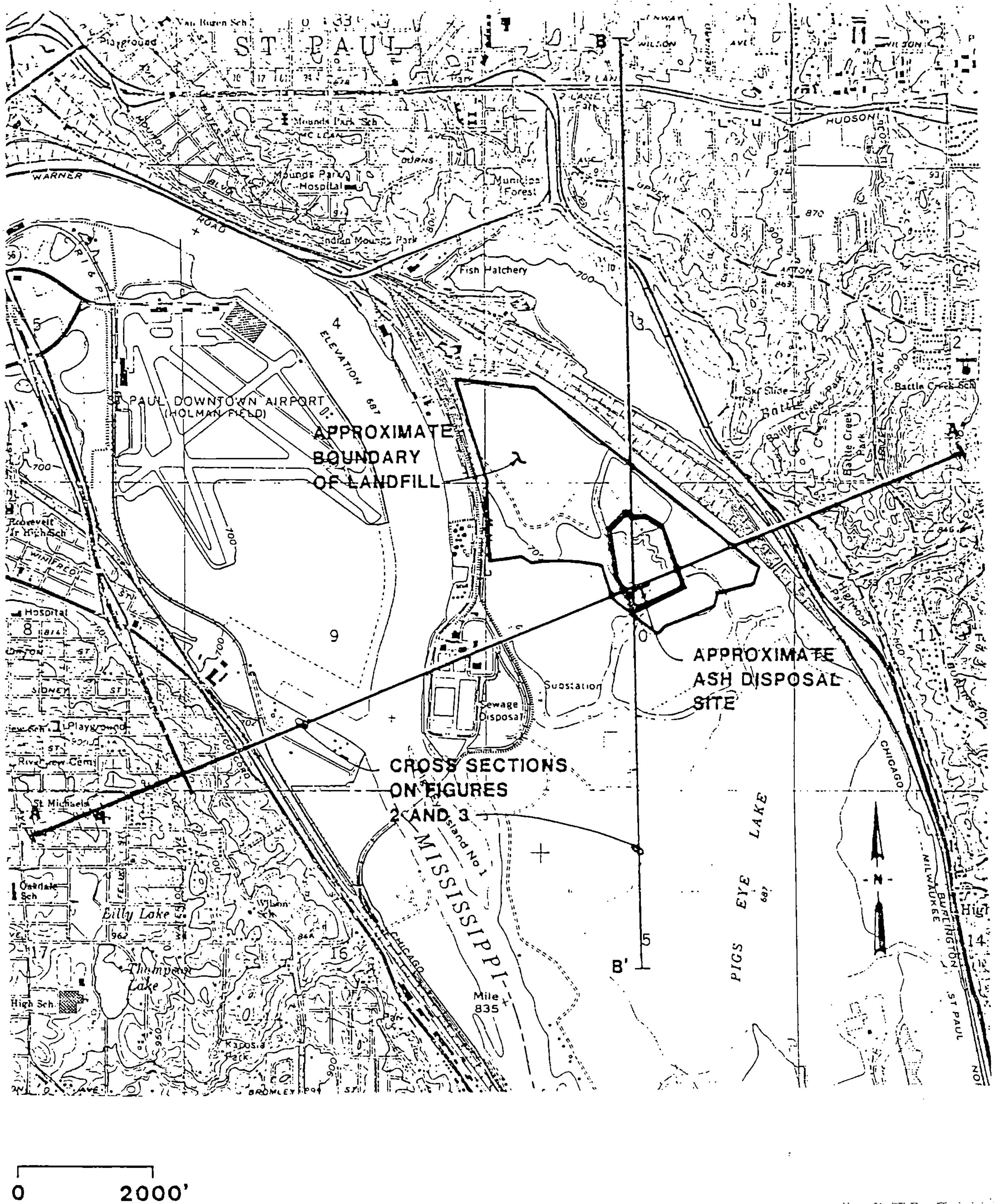


FIGURE 5-2: APPROXIMATE BOUNDARIES OF PIG'S EYE LANDFILL AND METRO ASH DISPOSAL AREA

Adapted from Consulting Engineers Diversified, Inc./ CH2M Hill, Inc., 1979.

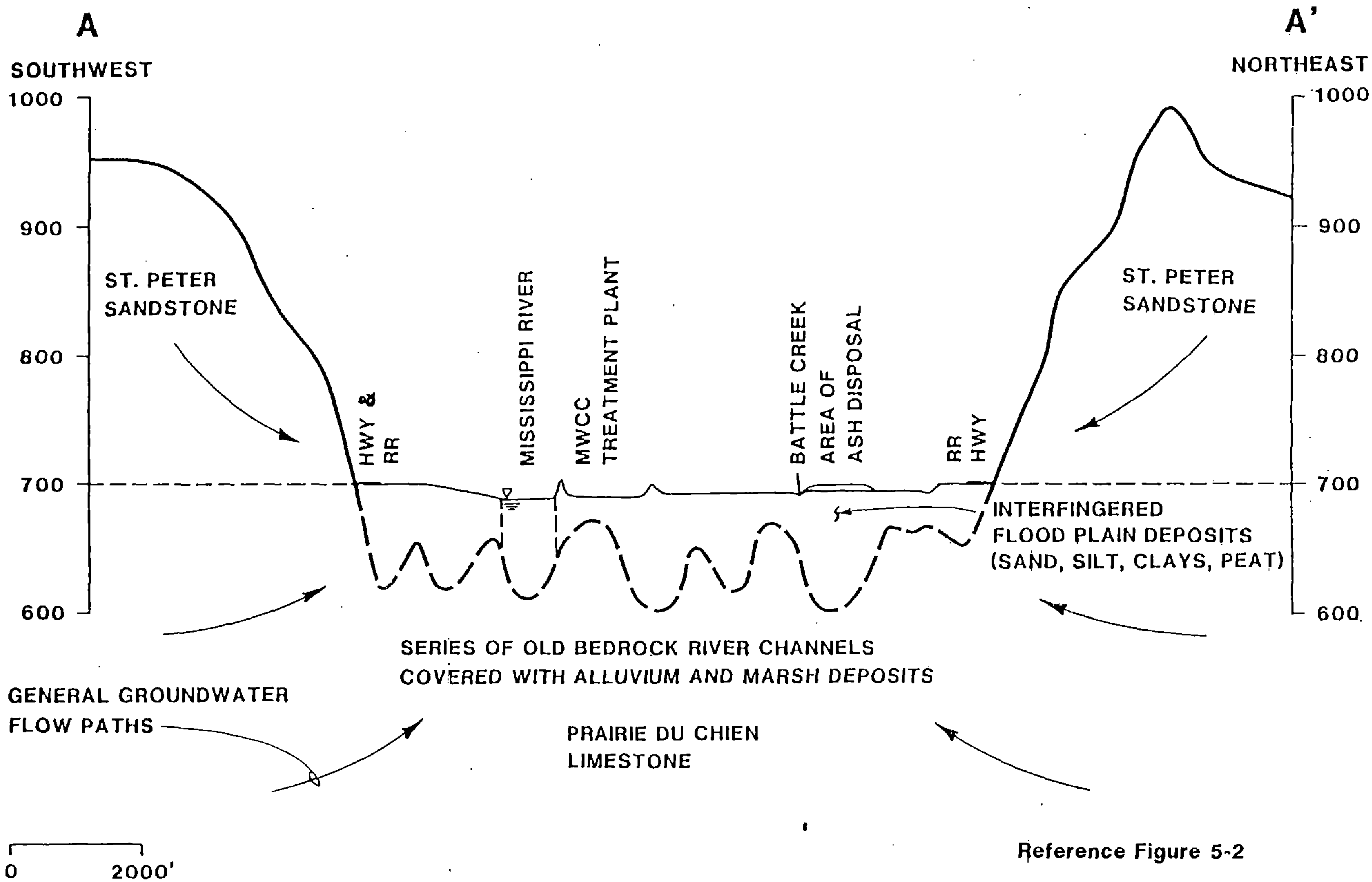


FIGURE 5-3: SOUTHWEST - NORTHWEST CROSS-SECTION OF PIG'S EYE LANDFILL
Adapted from Consulting Engineers Diversified, Inc./ CH2M Hill, Inc., 1979.

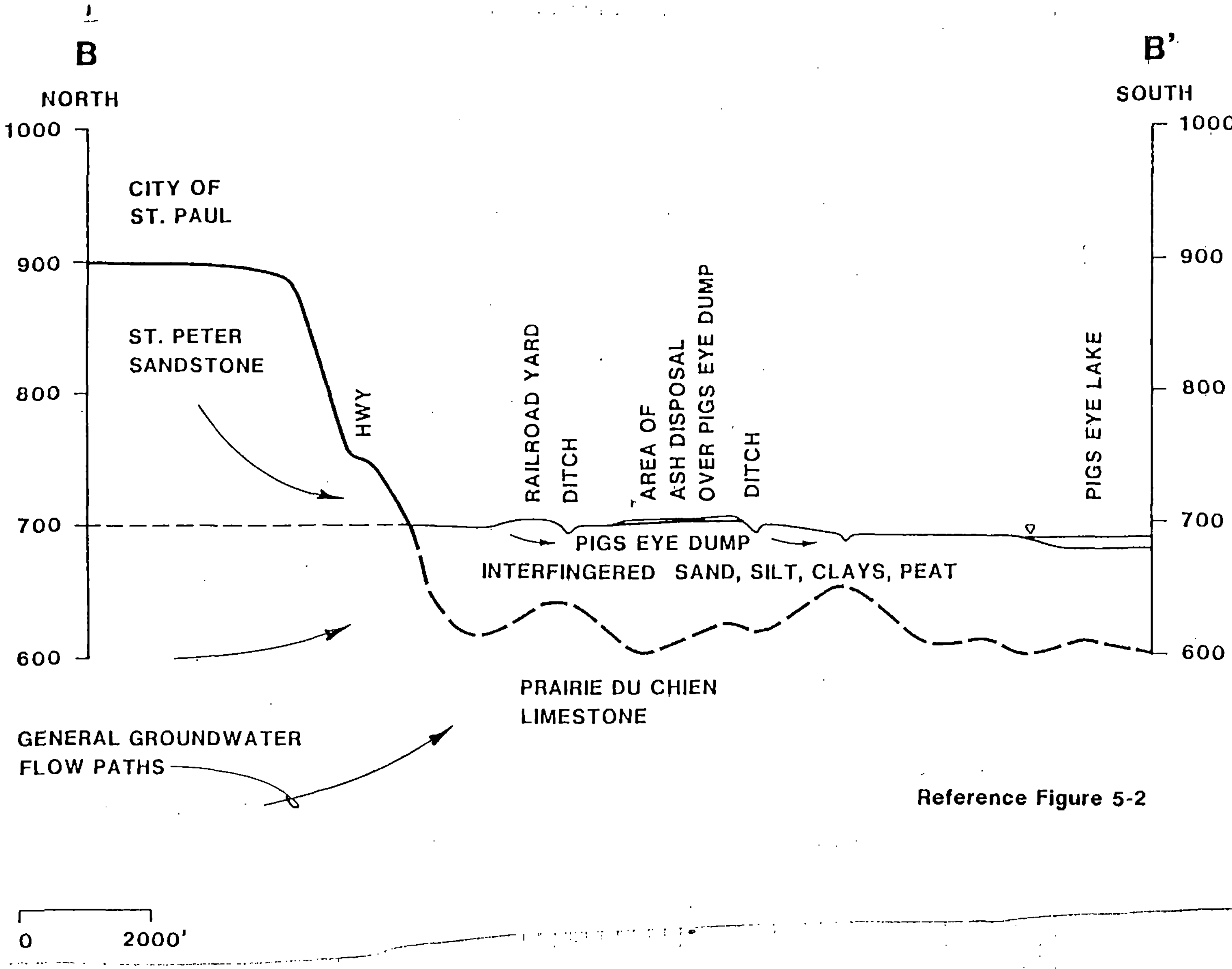


FIGURE 5-4: NORTH - SOUTH CROSS-SECTION OF PIG'S EYE LANDFILL

Adapted from Consulting Engineers Diversified, Inc./ CH2M Hill, Inc., 1979.

measurements taken in October 1988 of Metropolitan Waste Control Commission (MWCC) Ash Disposal Area Monitoring Wells and in December 1988 of the MPCA monitoring wells (Appendix H). Although the ground water elevations were taken approximately 3 months apart, previous reports submitted by MWCC indicate that ground water levels have fluctuated less than .5 feet throughout 1988 (Appendix H). Therefore, the elevations should provide an accurate indication of the direction of ground water flow in the surficial aquifer. Average ground water gradient across the Site is .42 (Figure 5-5).

Since the first monitoring wells and piezometers were installed at the Site in the 1970's, the ground water flow direction has been south to southwest toward the Mississippi River and Pig's Eye Lake. The exception to this apparent consistent flow direction is a ground water flow reversal recorded in April and May 1979. The surficial ground water flow was to the northeast during these two months before returning to a more "normal" flow direction to the southwest (Consulting Engineers Diversified, Incorporated/CH2M Hill, Incorporated, 1979). Since ground water elevation monitoring has been somewhat sporadic over the past 15 to 20 years, it is not possible to determine if the flow reversal of April and May 1979 was an isolated event or a seasonal variation.

6.0 SURFACE WATER

Battle Creek originates east of the Site, flowing westward through a man-made conduit beneath the Soo Line Rail Yards. The creek resurfaces at the eastern margin of the Site, flowing westerly before turning south and emptying into Pig's Eye Lake. The exact entry point of Battle Creek into Pig's Eye Lake is indeterminable due to the marsh area at the northern edge of the lake. The marsh tends to obscure the surface water flow path from Battle Creek into Pig'e Eye Lake. U.S. Geological Survey maps indicate Battle Creek flowed diagonally from northeast to southwest across the Site prior to 1967 (U.S. Geological Survey, 1967 and 1951). Between 1967 and closure of the Site in 1972, Battle Creek was rerouted along the western margin of the MWCC Ash Disposal Area (Figure 5-2).

Pig's Eye Lake is approximately 290 acres in size. The lake is connected to the Mississippi River at the lake's southern margin. The exact size of Pig's Eye Lake varies with the stage of the Mississippi River. The lake is used for recreational purposes, primarily fishing and boating. The Minnesota Department of Natural Resources maintains a heron rookery on the northwestern shore of the lake and monitors other water fowl using Pig's Eye Lake.

The Mississippi River is a large navigable river located ½ mile west of the Site. Average discharge is approximately 1200 cubic feet per second. The east bank area is heavily industrialized and also contains the MWCC Sewage Treatment Facility.

7.0 FIELD PROCEDURE

7.1 Site Reconnaissance Survey

A reconnaissance survey was conducted by MPCA staff at the Site on November 13, 1988. Evidence of periodic open dumping was present in the form of demolition debris, medical waste, and household garbage. All areas of the Site were showing inadequate final coverage with exposure of waste. The eastern margin of the Site was exhibiting the greatest amount of erosion. The exception to overall Site erosion was the ash fill area which had been furrowed and seeded (Figure 7-1).

Five on-site monitoring wells, used by the MWCC for monitoring of the ash fill for heavy metal leachate, were found to be in violation of the Minnesota Water Well Construction Code. Specifically, the wells are not protected by a minimum of three posts or concrete slab and the well heads are not covered with locking caps to prevent tampering. The MWCC records also indicate the wells are constructed entirely of polyvinyl chloride (PVC) casing and screens with glued joints. PVC construction and the use of glue make the wells inadequate for organic sampling (Sosebee, et al., 1983).

A soil and ground water investigation conducted for engineering purposes indicated 14 piezometers had been installed in 1973. Four piezometers were located but had been vandalized, therefore, water table elevations could not be taken. Remnants of drill rods and vanes used for vane shear tests on organic soils were also located and found to be damaged (Soil Exploration Company, 1971). The access roads were adequate for standard vehicle use, however, the roads across the Site were not routinely maintained. Due to snow cover, it was determined by MPCA staff that all-terrain type vehicles and drilling equipment would have to be used during the SSI.

7.2 On-Site Interviews

No on-site interviews were conducted during the SSI as Pig's Eye Dump is an inactive Site, but telephone interviews were conducted with former Pig's Eye

Landfill employees. MPCA files contained a 1969 list of former employees. Two former employees were willing to disclose information concerning other former employees, the dump activities, materials that were disposed of at the Site, and location of specific dumping areas. The identities of former employees are confidential, therefore, their names are not provided in this report (MPCA Files).

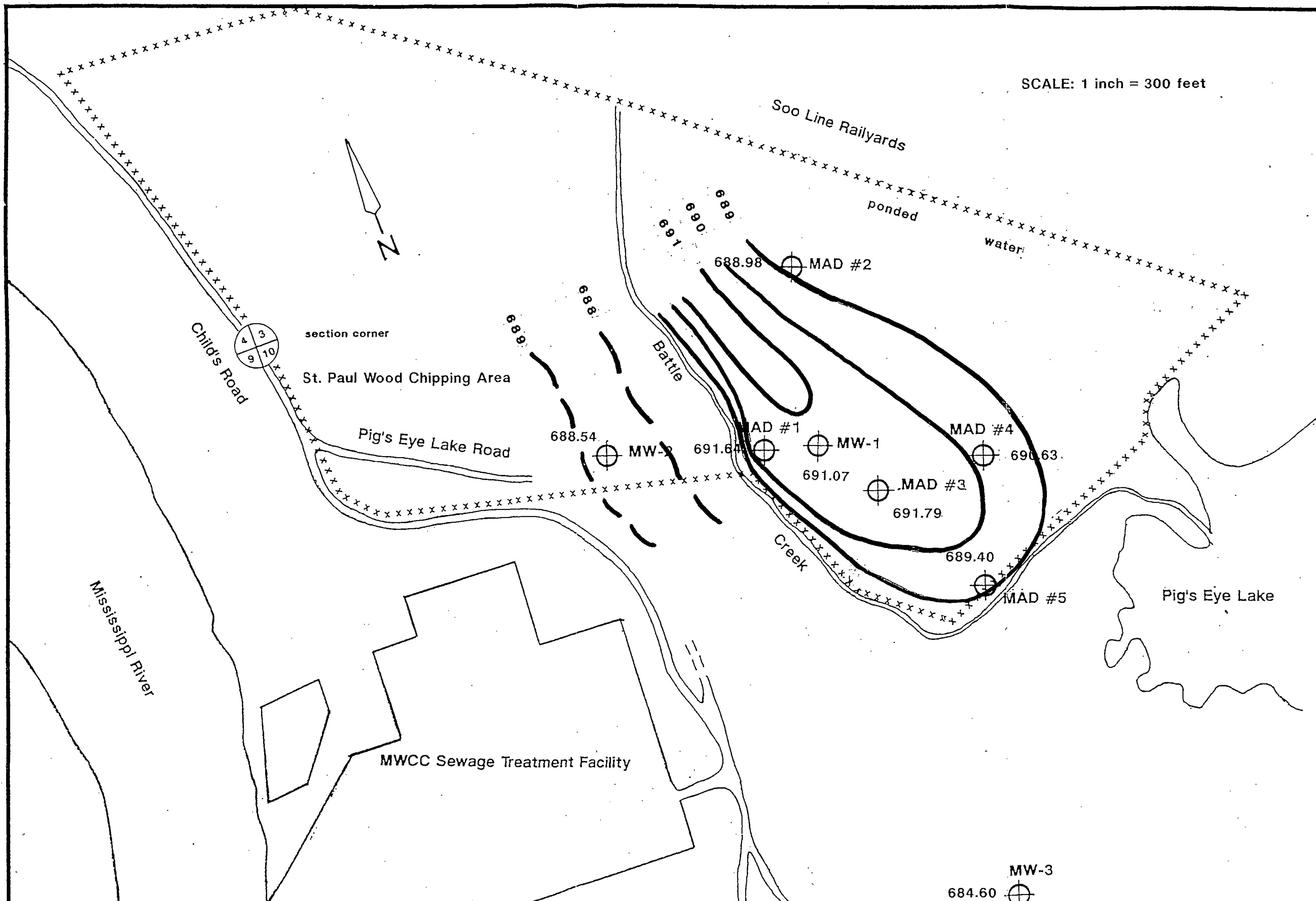
The first employee interviewed could not remember many details concerning actual dump operations, but was able to discern which of the former employees were alive or deceased. The second employee's name was provided by the first employee and subsequently interviewed by MPCA staff. The second employee was able to recall more detailed information concerning Site operations. The second employee stated the dump was divided into three areas; an area in the northern part of the Site was used primarily for demolition debris, a central portion was fenced for only 3M Corporation waste deposition, and the third area of the dump was to the south and was predominantly used for household waste. The former employee indicated the 3M Corporation area was located above a main sewer line. The southern area also received high amounts of waste from Ford Motor Company and Waste Control, Incorporated. The former employee stated efforts were made to keep hazardous waste from entering the Site, but waste was not always subjected to inspection. This and similar information was confirmed upon examination of the city of St. Paul's solid waste records (see Section 3.2).

7.3 Sampling Locations

The original work plan developed by the MPCA proposed 10 soil borings be taken, 4 permanent monitoring wells be installed and 3 surface water samples be taken.

An upgradient residential well was also chosen to establish background water quality levels in the aquifer of concern. The work plan was modified due to delayed access to the CMC Real Estate Corporation (CMC) property. The MPCA staff determined it was necessary to proceed with the SSI to maintain commitments established in U.S. EPA Cooperative Agreement No. V005848-01. The MPCA staff felt an adequate SSI could be performed without access to the CMC property due to the expansiveness of the Site and to the downgradient location of the remaining property which would provide sufficient opportunity to intercept contaminated ground water and/or surface water. Therefore, the CMC property was not investigated.

The modified work plan reduced the number of permanent monitoring wells to 3, the number of soil borings to 3 and the number of surface water samples to 2 (Figure 7-1). The well and boring locations were selected to maximize the downgradient capture of contaminated ground water, to gain general knowledge of the depth of waste and underlying natural stratum and establish background water quality for ground and surface water. In an effort to increase the number of ground water sampling points, while remaining within budgetary constraints, the 3 soil borings were also used for installation of temporary monitoring wells. With the exception of monitoring well (MW)-3 and the background well, all wells and borings were placed in the dump area (Figure 7-1). MW-3 was placed downgradient of the Site in an area that had not been subjected to dumping. The background well was a residential well, open-hole in the aquifer of concern. The background well was located at 444 Point Douglas Road, St. Paul (Figure 7-2).



NOTE: MPCA elevations taken 12/88 MWCC elevations taken 10/88

FIGURE 5-5 GROUND WATER FLOW IN THE SURFICIAL AQUIFER

KEY

MW = MPCA monitoring well

MAD = MWCC Ash Disposal Area monitoring well

Contour interval = 1 foot

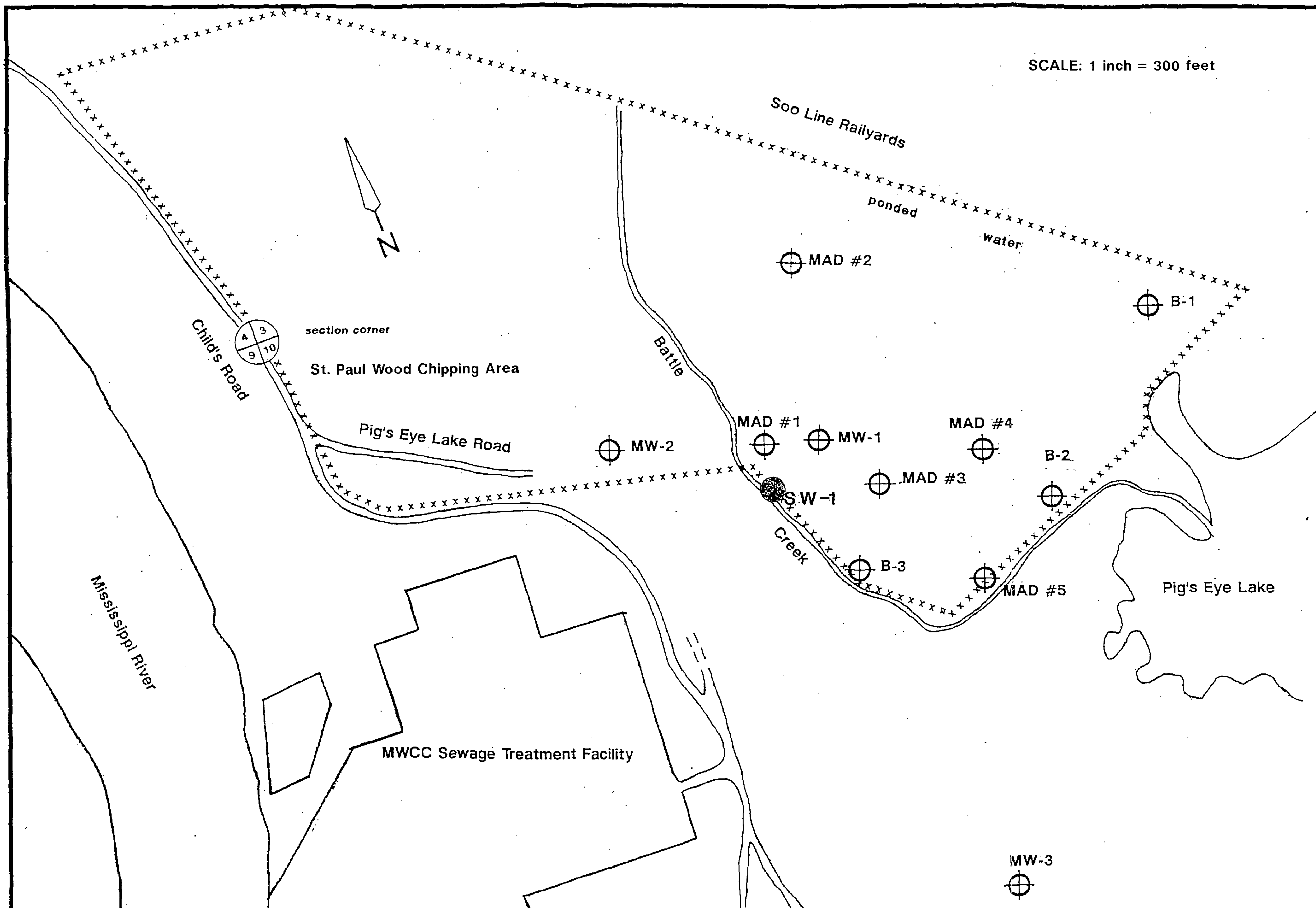


FIGURE 7-1 SOIL BORING AND MONITORING WELL LOCATIONS

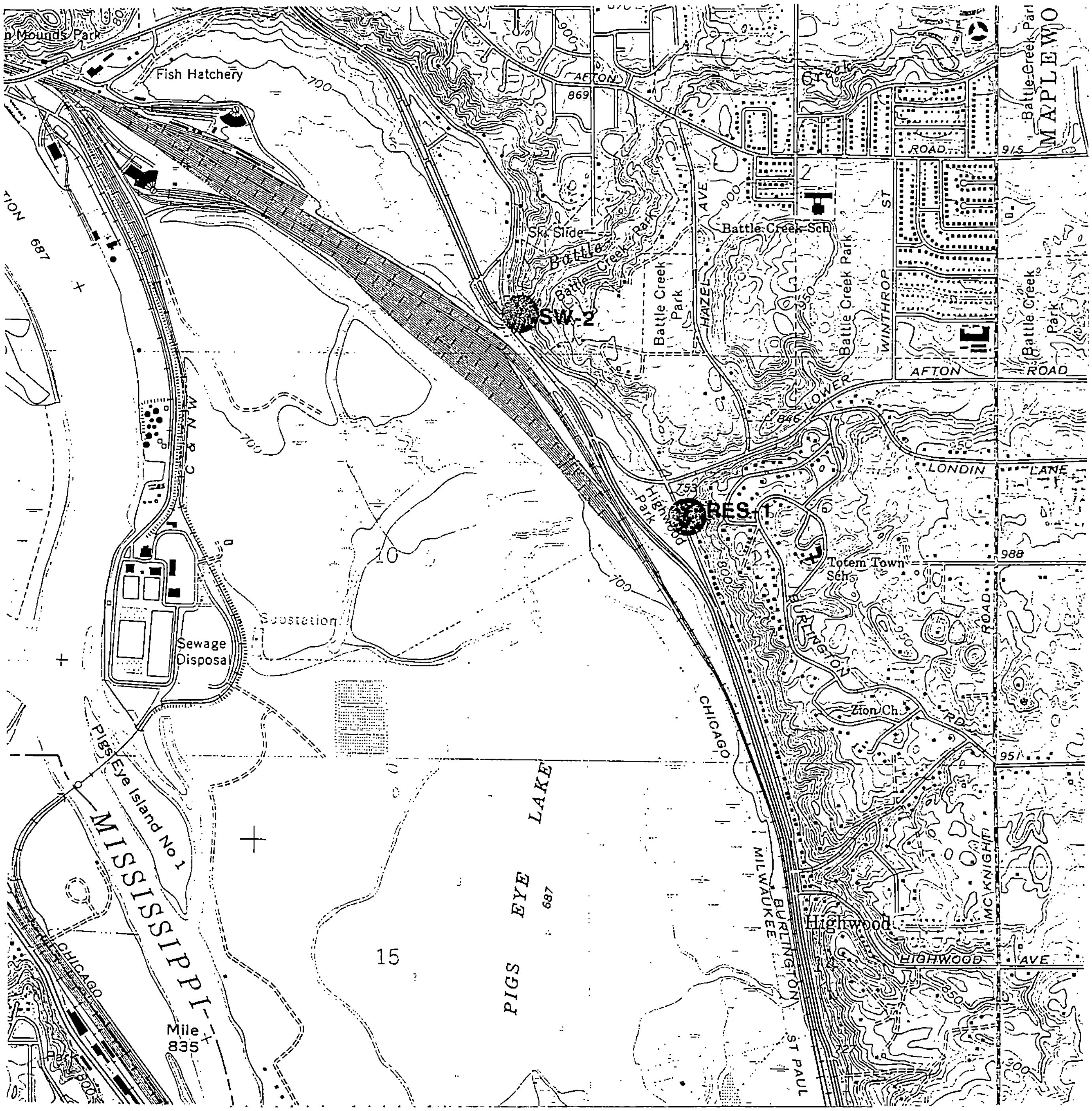
KEY

MW = MPCA monitoring well

MAD = MWCC Ash Disposal Area monitoring well

B = MPCA soil boring

SW = surface water sample point



KEY

SW = Surface water sample

RES = Residential well

FIGURE 7-2 BACKGROUND SURFACE AND GROUND WATER SAMPLE LOCATIONS

Table 7-1 Sample Locations

Traffic Number Report	Sample Number	Sample Location	Sample Depth	Designate	HNu/OVA Readings
EAQ 76 MEAJ 71	S01	B-1	14.5′	Soil Grab	-
EAQ 77 MEAJ 72	S02	B-2	12.5′	Soil Grab	90 ppm OVA
EAQ 78 MEAJ 73	S03	B-3	17.6"	Soil Grab	1000 ppm OVA
EAQ 79 MEAJ 74	S04	MW1	?	Soil Grab	1000 ppm Down HSA OVA**
EAQ 80 MEAJ 75	S05	MW2	15′ - 17′	Soil Grab	1000 ppm Down HSA OVA ** 10 ppm ambient
EAQ 81 MEAJ 76	S06	MW3	0′ - 2′ 2′ - 4′ 4- - 6 ′ 11′ - 13′	Soil Composite	-
EAQ 88	R01	N/A	N/A	Ground Water Trip Blank	-
EAQ 89 MEAJ 83	R02	N/A	N/A	Ground Water Field Blank	-
EAQ 90 MEAJ 84	S13	B-2	N/A	Ground Water	-
EAQ 91 MEAJ 85	D01	B-1	N/A	Ground Water	-
EAQ 92 MEAJ 86	S14	B-1	N/A	Ground Water	-
EAQ 93	S15	B-3	N/A	Ground Water	-

Table 7-1 (Continued)

Traffic Number Report	Sample Number	Sample Location	Boring Depth	Designate	HNu/OVA Readings
EAQ 94 MEAJ 88	S16	SW2	N/A	Surface Water	-
EAQ 95 MEAJ 89	D02	SW2	N/A	Surface Water	-
EAQ 96 MEAJ 90	S17	SW1	N/A	Surface Water	-
EAQ 82	R03	N/A	N/A	Ground Water Trip Blank	-
EAQ 83 MEAJ 77	R04	N/A	N/A	Ground Water Field Blank	-
EAQ 84 MEAJ 78	S18	MW2	N/A	Ground Water	-
EAQ 85 MEAJ 79	S19	MW3	N/A	Ground Water	-
EAQ 86 MEAJ 80	D03	MW3	N/A	Ground Water	-
EAQ 87 MEAJ 81	S20	MW1	N/A	Ground Water	-
EAQ 97	R05	Trip Blank	N/A	Ground Water	-
EAQ 98 MEAJ 82	R06	Field Blank	N/A	Ground Water	-
EAQ 99 MEAJ 91	S21	RES 1	N/A	Ground Water	-
EY 700 MEAJ 92	S21	RES 1	N/A	Ground Water	-

The surface water sampling points were originally chosen to assess water quality of Battle Creek and ponded water area along the eastern margin of the Site (Figure 7-1). Although the original work plan called for a surface water sampling in the ponded water area along the eastern margin of the Site, this could not be accomplished due to denied property access. An upstream location in Battle Creek Park adjacent to Point Douglas Road was used to establish background surface water quality (Figure 5-2). A second downstream location was chosen along the western margin of the MWCC Disposal Area (Figure 7-1). Water in Pig's Eye Lake was not sampled due to ice coverage.

7.4 Sampling Procedures

The soil borings were advanced with a CME Model 25 through a 2¼ inner diameter (I.D.) hollow-stem auger (HSA). The borings utilized for permanent well installation were advanced with a CME Model 550. Soil samples were taken with a split-spoon sampler by driving the sampler 18 inches ahead of the HSA. Blow counts and depth were recorded as detailed under ASTM Standard D1586 (Appendix E). Personal protection safety monitoring and sample screening were conducted with an organic vapor analyzer (OVA). The background level of 5 parts per million (ppm) was exceeded while drilling B-3 (Table 7-1). The MPCA staff and drillers used Level C personal protection safety equipment to complete sampling of B-3.

Soil borings, B-1, B-2 and B-3 were used as soil sampling points as well as for installation of temporary monitoring wells. Sample intervals and corresponding borings are exhibited in Table 7-1. Initially, a 10-slot screened HSA was used in an attempt to extract a ground water sample, but due to a high amount of fine clay and peat material smearing against the auger screen the boring would not adequately recharge. An alternative method of dropping a 10-foot, 10-slot screen through the auger and exposing it by pulling back the auger was used to install "temporary monitoring wells." The wells were then sampled with stainless steel bailers after initially bailing a minimum of five well column volumes to induce recharge into the well for representative sampling. This method allowed ground water samples to be obtained without incurring the additional expense of a permanent well installation. Two major drawbacks to this method of sampling is the lack of duplicity of a ground water sampling point at a later date and the relatively poor quality of ground water samples due to a high amount of fines.

Three permanent monitoring wells were constructed with a 2 inch I.D. stainless steel casing and 10 feet long, 2 inch I.D., 10 slot stainless screens. The screens were installed in the first water-bearing formation and split the water table (Appendix E). MW-1 and MW-2 are screened in the lower part of the fill. MW-3 is screened in natural alluvium. Since the Site is located in a floodplain, a variance in well construction methods was requested from the Minnesota Department of Health (MDH). Specifically, Minn. Rules ch. 4725.2200, subp. 1 states "a well shall not be located in areas subject to flooding unless the casing extends at least two feet above the level of the highest known flood of record or otherwise protected as prescribed in writing by the administrative authority." To avoid using cumbersome and costly casing extensions, a two inch flush threaded plug with a sealing O-ring (Johnson Screens #6600126) was used to provide well head protection in the event of flooding. All other well construction was constructed in accordance with the Minnesota Water Well Construction Code.

After monitoring well installation was completed, Geotechnical Engineering Corporation, the MPCA drilling contractor, surveyed all MPCA and MWCC monitoring wells and MPCA soil boring locations. A benchmark of 100.0 feet was assumed at the top of a fire hydrant located at the main building of the wood chipping facility (Figure 7-1). Elevations were determined at the top of each casing. The city of St. Paul surveyor's office supplied the elevation of the fire hydrant at a later date (Brady, 1989). Further details concerning surveying are available in Appendix E.

Precisional Environmental Services (Precision) performed monitoring well development and stabilization through pH, conductivity and temperature on MW-1, MW-2 and MW-3 on January 11 and 12, 1989 (Appendix F). Immediately after the stabilization was completed for each well, a stainless steel bailer was used to collect a sample. Prior to sampling the background residential well at 444 Point Douglas Road, the tap was allowed to remain open for 30 minutes to fully evacuate any stagnant ground water in the water column.

Surface water samples were collected by submerging the respective sampling containers beneath the water line and allowing it to fill to capacity. Ice had formed over Battle Creek where the upstream sample, SW-2, was collected. Therefore, the larger bottles could not be submerged beneath the water. A 500 milliliter stainless steel container was used to collect the surface water through a small crack in the ice. The sample was then transferred to the appropriate sample container.

A trip blank for Volatile Organic Analysis (VOA) was stored with the water samples throughout the samping event. A field blank was taken from a clean bailer prior to sampling MW-1. All additional quality control/quality assurance (QA/QC) guidelines were followed, as detailed in the MPCA Quality Assurance Program Plan (QAPP) and U.S. EPA Contract Laboratory Program (CLP) guidelines, to insure sample integrity.

Soil samples from all borings and monitoring wells and temporary well ground water samples from B-1 through B-3 were analyzed by Kemron in Baton Rouge, Louisiana for organic compounds and by Allied Analytical Research in Carrollton, Texas for inorganic analytes. Monitoring wells and surface water samples were analyzed for organic compounds by Pace Laboratories, Incorporated, Minneapolis, Minnesota and for inorganic analytes by Enseco/Rocky Mountain Analytical in Arvada, Colorado. Residential well sample analysis for organic compounds and inorganic analytes was performed by Versar, Inc. of Springfield, Virginia and Enseco/Rocky Mountain Analytical in Arvada, Colorado, respectively. All samples were analyzed for compounds and analytes listed on U.S. EPA Target Compound List (TCL) and Target Analyte List (TAL). All data received a QA/QC review by an MPCA staff person who has received CLP data review training.

Photographs were taken at all sampling points and identified appropriately. A camera malfunction during the SSI field work in December 1988, resulted in destruction of the film. Subsequent photographs were taken in January 1989, however, the film was damaged in processing. Replacement photographs were taken in April 1989, to complete the photographic documentation at the Site.

8.0 ANALYTICAL RESULTS

Chemical analysis of ground water and soil samples revealed substance from the following groups of TCL compounds and TAL analytes to be present: solvents, hydrocarbons, PAHs, heavy metals and common laboratory contaminants. Tables 8-1 - 8-8 contain a summary of all TCL compounds and TAL analytes detected in the samples. The complete analytical results can be found in Appendix K.

9.0 MIGRATION PATHWAYS

9.1 Ground Water

Laboratory results from soil samples taken from the lower depths of the fill and at the fill/soil interface indicate contaminants are present in the landfill. Monitoring well samples indicate these contaminants have also been releases to the ground water.

All soil samples taken at the Site indicate moderate to high levels of organic compounds such as pesticides, napthas, anthrenes, and phthalates are present in Pig's Eye Landfill. Soils taken from borings B-1, B-2 and B-3 along the southern margin of the Site appear to be more highly contaminated than those taken from MW-1, MW-2 and MW-3 borings. Although MW-3 is not located in a known fill area, 4,4'-DDD and bis(2-ethylhexyl) phthalate were detected in the soil (Table 8-1). The higher contamination along the southern margin may be attributed to leachate generation and the cumulative affects prior to discharge along the southern margin of the Site.

Table 8.1

Summary of
Chemical Analysis For
Volatile and Semi-Volatile: Soil

Sample Collection Information and Detected Parameters	Sample Number S01	S02	S03	S04	S05	S06	
Date	12/12/88	12/12/88	12/13/88	12/13/88	12/19/88	12/19/88	
Time	1630	1430	1159	1210	956	245	
Organic Traffic Report Number	EAQ 76	EAQ 77	EAQ 78	EAQ 79	EAQ 80	EAQ 81	
Sample Location	B1	B2	B3	MW 1	MW 2	MW 3	
Compound Detected (ug/L ppb unless indicated)							
Methylene Chloride	4J			7J	7J	4J	
Total Xylenes	6J						
2-Butanone				17J			
Naphthalene	66J	170J					
2-Methylnaphthalene	130J	100J					
Phenanthrene	140J	98J					
Fluoranthene	110J	120J	86J				
Pyrene	90J	160J	77J				
Chrysene	56J	88J					
bis(2-Ethylhexyl)Phthalate	4600	5900	950	180J	180J	160J	
Benzo(b)Fluoranthene	52J	130J	63J				

Table 8.1 (continued)

Compound(s) Detected (ug/L)	S01	S02	S03	S04	S05	S06	
	Sample Number						
1,4-Dichlorobenzene		330J					
Di-n-Butylphthalate		99J					
Butulbenzylphthalate		67J					
Benzo(a)Anthracene		70J					
Benzo(a)Pyrene		99J					
Heptachlor epoxide	8.3J						
4,4'-DDD		150				56	
Dieldrin			2.4J				
Endrin Ketone			39				

Table 8.2

Summary of
Chemical Analysis For
Metals and Cyanide: Soil

Sample Collection Information and Detected Parameters	S01	S02	S03	S04	S05	S06	
Date	12/12/88	12/12/88	12/13/88	12/13/88	12/19/88	12/19/88	
Time	1630	1430	1159	1210	956	245	
Sample Location	B-1	B-2	B-3	MW1	MW2	MW3	
Inorganic Traffic Report Number	MEAJ71	NEAJ72	MEAJ73	MEAJ74	MEAJ75	MEAJ76	
Compound Detected (mg/kg)							
Aluminum	5320	8590	8590	8180	8490	7510	
Antimony		41.B					
Arsenic	2.10J	4.8J	3.8J	4.2J	4.8J	2.2J	
Barium							
Beryllium			0.82B		0.38B	0.69B	
Cadmium	0.67B	2	0.88B	1.6	1.5	0.95B	
Calcium	4250	27200	32300	25800	44200	32100	
Chromium	18	24.2	21.8	22.2	23.8	19.1	
Cobalt	6B	11.1	8.9B	10B	9.9B	10.2	
Copper	14.6	23.5	21	20	17.9	15	
Iron	154000	36300	20900	30500	28700	23300	

Compound(s) Detected (ug/L)	S01	S02	S03	S04	S05	S06	
	Sample Number						
Lead	57J	27.3J	35.7J	20.8J	38.4J	7.5J	
Magnesium	2050J	13200J	14300J	15400J	18900J	15800J	
Manganese	199	2880	1590	1150	3270	1450	
Mercury			0.3				
Nickel	14.9	34.4	23.1	24.4	32	22.6	
Potassium	312B	594B	932B	1080	664B	556B	
Selenium		1.5J					
Vanadium	21.7	33	30.2	26.9	31.2	27.7	
Zinc	96.2	124	78.7	74.1J	62	48.9	

Table 8.3

Summary of
Chemical Analysis For
Volatile and Semi-volatile: Ground Water and Surface Water

Sample Collection Information and Detected Parameters	Sample Number								
	R01	R02	S13	D01	S14	S15	S16	D02	S17
Date	12/21/88	12/21/88	12/12/88	12/12/88	12/13/88	12/13/88	12/21/88	12/21/88	12/21/88
Time	1400	1415	1300	1300	950	1300	1100	1100	1000
Organic Traffic Report Number	EAQ88	EAQ89	EAQ90	EAQ91	EAQ92	EAQ93	EAQ94	EAQ95	EAQ96
Sample Location	TB	FB	B2	B2	B1	B3	SW2	SW2	SW1
Compound Detected (ug/L ppb unless indicated)									
Acetone	3J	18			1J				40
Benzene			8	9		21			
Chlorobenzene			7	6					
Total Xylenes			3J	3J	5	95J			
Methylene Chloride						1900			2J
Toluene						22J			
Ethylbenzene									2J
Styrene									4J
Phenol		3J	2J						
1,4-Dichlorobenzene			17	29J					
4-Methylphenol			4J		4J	52J			

Table 8.3 (continued)

	Sample Number								
Compound(s) Detected (ug/L)	R01	R02	S13	D01	S14	S15	S16	D02	S17
Naphthalene			20	33J	27	23			
2-Methylnaphthalene			9J	17J	21	9J			
Di-n-Butylphthalate			3J						
Butylbenzylphthalate			2J						
Benzoid Acid				35J					
1,2-Dichlorobenzene						23			
Nitrobenzene						9J			
2,4-Dimethylphenol						9J			
Phenanthrene					14	3J			
Di-n-Octyl Phthalate								3J	
Acenaphthene					3J				
Fluorene					3J				
Fluoranthene					8J				
Pyrene					6J				
Benzo(a)Anthracene					3J				
Chrysene					4J				
Benzo(b)Fluoranthene					4J				
Heptachlor epoxide			0.053J	.11					
4,4'-DDD			6.0	5.9	0.49				
Dieldrin					0.35J				
Aroclor 1016						230			

Table 8.4

Summary of
Chemical Analysis For
Metals and Cyanide: Ground Water and Surface Water

Sample Collection Information and Detected Parameters	Sample Number R02	S13	D01	S14	S15	S16	D02	S17	
Date	12/21/88	12/21/88	12/21/88	12/13/88	12/13/88	12/21/88	12/21/88	12/21/88	
Time	1415	1300	1300	950	1300	1100	1100	1000	
Sample Location	FB	B2	B2	B1	B3	SW2	SW2	SW1	
Inorganic Traffic Report Number	MEAJ83	MEAJ84	MEAJ85	MEAJ86	MEAJ87	MEAJ88	MEAJ89	MEAJ90	
Compound Detected (ug/L ppb unless indicated)									
Aluminum	122B	195000J	198000J	75300J	242000J				
Antimony		73.2J	64J	20.7BJ	106J				
Arsenic		71.1J	90.9J		68.8J			3.4BJ	
Barium	70.8J	8360J	8290J	1550J	8160J	152BJ	151BJ	186BJ	
Beryllium									
Cadmium	1.6J	197J	194J	32.9J	389J				
Calcium	356B	413000	426000	129000	663000	78100	77100	90600	
Chromium		666J	692J	262J	1600J				
Cobalt		198	202	77.2	674				
Copper	10.4BJ	1640J	1640J	462J	4550J	12.6BJ	10.8BJ	9.1BJ	
Iron	45.2BJ	1050000J	1020000J	306000J	1320000J	349J	178J	786J	

Compound(s) Detected (ug/L)	R02	S13	D01	S14	S15	S16	D02	S17	
				Sample Number					
Lead		7600J	7620J	2120J	18400J	4BJ	2.4BJ	2.5BJ	
Magnesium		190000J	196000J	54300J	232000J	27000J	26700J	33500J	
Manganese		12400	12700	5880	12300	108	106	462	
Mercury		8.1	6.2	1.5	130				
Nickel		982J	974J	297J	104J				
Potassium		88100	90000	13000	125000	4640B	4580B	4190B	
Sodium	1150B	357000	364000	15200	278000	252000	249000	972000	
Vanadium		324	333	223	372				
Zinc		22800J	22800J	5370J	27800J	35.5	29J	22.4J	
Cyanide			22	36	110				

Table 8.5

Summary of
Chemical Analysis For
Volatile and Semi-Volatile: Ground Water

Sample Collection Information and Detected Parameters	Sample Number R03	R04	S18	S19	D03	S20
Date	1/12/89	1/12/89	1/11/89	1/11/89	1/11/89	1/12/89
Time	1415	1135	1204	1445	1445	1135
Organic Traffic Report Number	EAQ82	EAQ83	EAQ84	EAQ85	EAQ86	EAQ87
Sample Location	TB	FB	MW2	MW3	MW3	MW1
Compound Detected (ug/L ppb unless indicated)						
Methylene Chloride	6					
Benzene			2J			21
Chlorobenzene						2J
Xylene (total)						31B
Diethylphthalate						10

Table 8.6

Summary of
Chemical Analysis For
Metals and Cyanide: Ground Water

Sample Collection Information and Detected Parameters	Sample Number R04	S18	S19	D03	S20				
Date	1/12/89	1/11/89	1/11/89	1/11/89	1/12/89				
Time	1135	1204	1445	1445	1135				
Inorganic Traffic Report Number	MEAJ77	MEAJ78	MEAJ79	MEAJ80	MEAJ81				
Sample Location	FB	MW2	MW3	MW3	MW1				
Compound Detected (ug/L ppb unless indicated)									
Aluminum		25300	14100	12600	112000				
Antimony		28.7B							
Arsenic		194	8.4B	6.5B	83.4				
Barium	2.6B				7.5				
Beryllium		1.3B							
Cadmium									
Calcium									
Chromium		91.4	41.2	42.4	269				
Cobalt		39.1B	19.2B	17.1B	155				
Copper	7.6B								
Iron	17.5B								

Table 8.6 (continued)

	Sample Number								
Compound(s) Detected (ug/L)	R04	S18	S19	D03	S20				
Lead	4.6B	70.2	9.0	7.3	776				
Magnesium									
Manganese		8560	10900	10100	16100				
Mercury					4.7				
Nickel		95.5J	39.5J	38.4J	340J				
Potassium									
Silver					4.6B				
Sodium		165000	76900	76900	329000				
Vanadium		87.4	42.3B	38.6	429				
Zinc	12.1J	290JR	91.2JR	81.4JR	2940JR				
Cyanide		69.8			38.7				

Table 8.7

Summary of
Chemical Analysis For
Volatile and Semi-Volatile: Residential Well

Sample Collection Information and Detected Parameters	Sample Number								
	R05	R06	S21	D04	S21				
Date	1/12/89	1/12/89	1/11/89	1/11/89	1/11/89				
Time	1430	1435	1730	1730	1730				
Organic Traffic Report Number	EAQ97	EAQ98	EAQ99	EY700	EAQ99RE				
Sample Location	Trip Blnk.	Fld. Blnk.	Res 1	Dup	Res 1				
Compound Detected (ug/L ppb unless indicated)									
Chloroform		0.70							
2-Butanone		3.74							
Trichloroethene		0.27							
Benzene		0.16							
Acrolein		12.49							
Di-n-butylphthalate			1.94J						
TENTATIVELY IDENTIFIED COMPOUND LIST									
Unknown Heteocyclic Amine					10J				

Table 8.8

Summary of
Chemical Analysis For
Metals and Cyanide: Residential Well

Sample Collection Information and Detected Parameters	Sample Number: R06	S21	D04						
Date	1/12/89	1/11/89	1/11/89						
Time	1435	1730	1730						
Sample Location	MEAJ82	MEAJ91	MEAJ92						
Inorganic Traffic Report Number	FB	RES1	RES1						
Compound Detected (ug/L ppb unless indicated)									
Aluminum		278J	229J						
Antimony									
Arsenic									
Barium		69.7	68.3						
Beryllium									
Cadmium	0.3B		0.1B						
Calcium		76000	75400						
Chromium									
Cobalt									
Copper	3.2B	12.1J	7.4B						
Iron	22.7B	2210	1990						

Table 8.8 (continued)

	Sample Number									
Compound(s) Detected (ug/L)	R06	S21	D04							
Lead	8.7	2.8	3							
Magnesium		28400	28000							
Manganese		1060	1050							
Potassium		1740	1650B							
Sodium		7310	6010							
Zinc	2B	281	192							

Inorganic analytes with elevated levels include antimony, chromium, lead, nickel, vanadium, and zinc (Table 8-2). Metal levels were three to five times ambient levels in soils but were not above recommended action level (Gough, et al., 1979).

Ground water contaminants in B-1, B-2 and B-3 included many of the same organic contaminants detected in the soil samples taken from the borings (Tables 8-1 and 8-3). The Minnesota Department of Health Recommended Allowable Limit (RAL) of 48 ug/l for methylene chloride was exceeded with a level of 1900 ug/l in water extracted from B-3. Ground water samples taken from MW-1 and MW-2 showed minimal organic contaminants associated with the Site (Table 8-5). MW-3 showed no ground water contamination above laboratory detection limits and a phthalate compound in the soil sample associated with the boring (Table 8-5).

Only one organic compound, an unknown hetrocyclic amine, was detected in the residential well used to establish background, but was undetected in downgradient wells (Table 8-7). The compound is most likely from another source upgradient of the background well or from an undetected laboratory or field source.

Inorganic analytes in ground water samples have exceeded many RALs established for metals. Arsenic levels exceeded the RAL of 50 ug/l in all wells sampled with the exception of MW-3. The highest detected arsenic level was 194 ug/l in MW-2. Barium concentrations were from one to five times greater than the RAL of 1500 ug/l in B-1, B-2 and B-3 ground water. Wells MW-1, MW-2 and MW-3 were all below 10 ug/l for barium. Cadmium was detected at extremely high concentrations in B-1 through B-3. Cadmium levels ranged from 32.9 ug/l in B-1 to 389 ug/l in

B-3, far exceeding the RAL of 5.0 ug/l. Chromium was detected at levels greater than the RAL of 120 ug/l in B-2, B-3 and MW-1. B-3 ground water contained the greatest amount of chromium, 1600 ug/l. Copper, which was undetected in the background residential well, exceeded the RAL of 1300 ug/l in B-2 and B-3. An extremely high amount of lead was detected in MW-1 at 18,400 ug/l. MW-3 contained the only ground water sample with lead at negligible concentrations. Mercury levels exceeded the RAL of 1.1 ug/l in samples taken from B-1, B-2, B-3, MW-1 and MW-2. Nickel has a RAL of 150 ug/l which was exceeded by two to seven times in B-1, B-2 and MW-1. Many of the other metal levels did not exceed RALs but they were considerably higher than levels detected in the background residential well (Tables 8-4, 8-6 and 8-8).

The source of the metals can be partially attributed to the ash fill; MWCC quarterly ground water sampling reports indicate metals are leaching from the ash disposal area. This does not explain the elevated metals in samples taken from MW-2, which is located northwest and upgradient of the ash disposal area. Therefore, the metal contamination is probably a combination of sources throughout the Site.

9.2 Surface Water

The upstream surface water sample (SW-2) taken in Battle Creek showed no contaminants were present above detection limits. Acetone was detected at 40 ug/l at the downstream sampling point (Figure 7-1 and Table 8-3). However, acetone was not detected in the soil samples taken at the Site. This lack of acetone in a soil sample disallows the assumption that an observed release of acetone from the Site to surface water in Battle Creek has occurred. This does not disprove the contamination of Pig's Eye Lake via ground and surface water interaction. An observed release to Pig's Eye Lake or the Mississippi River cannot be documented due to lack of sampling data.

9.3 Air Migration

Air monitoring was performed in June 1988 when the Site caught fire. Bay West, Incorporated, an MPCA contractor, detected hydrogen cyanide gas in smoke emanating from the Site. The Site has been extinguished since August 1988 and no longer emits any gaseous compounds due to fire.

9.4 Direct Contact

Direct Contact is possible since waste is exposed, leachate is being generated and the Site is unsecured.

9.5 Fire and Explosion

The possibility for fire is present during months of heavy equipment use by the city of St. Paul Parks and Recreation Department at the wood chipping facility.

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